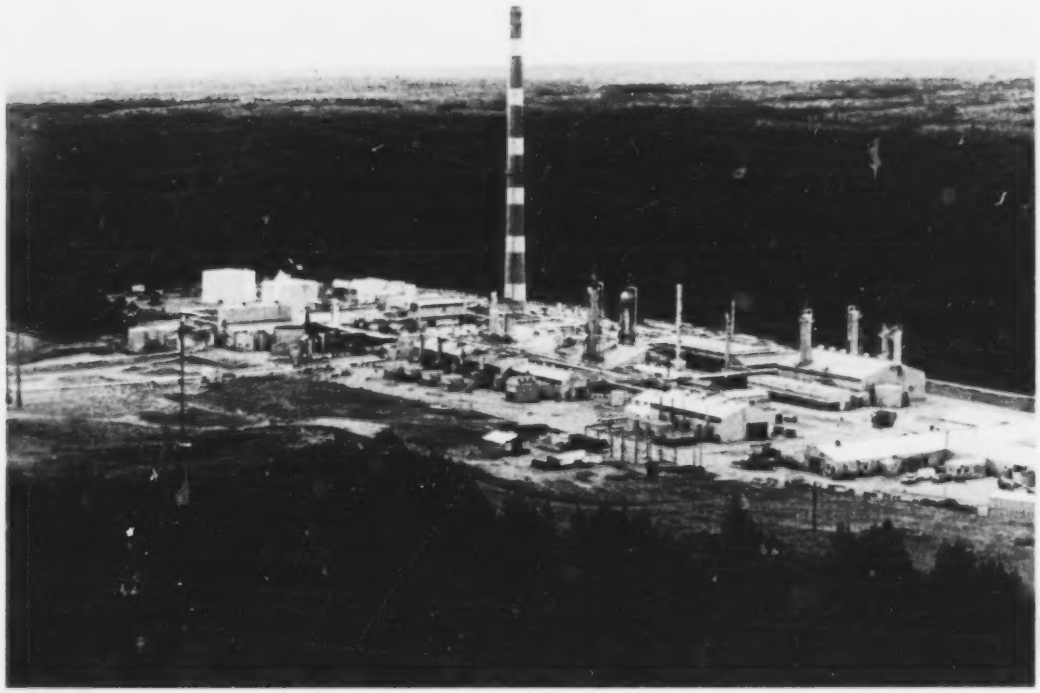
ST101-2006

EUB

Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

Annual Report

August 2006



Alberta Energy and Utilities Board

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ST101-2006: Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

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1 Introduction

In *Interim Directive (ID) 2001-3: Sulphur Recovery Guidelines for the Province of Alberta*, the Alberta Energy and Utilities Board (EUB) committed to monitoring the sulphur recovery of grandfathered[1] sour gas plants and publishing an annual summary report on industry performance. This report covers both grandfathered sour gas plants (sulphur recovery and larger acid gas flaring sour gas plants) and nongrandfathered[2] gas plants (sulphur recovery and all acid gas injection sour gas plants). A complete list of the grandfathered and nongrandfathered plants is in Appendices 2.1-2.4.

While *ID 2001-3* did not change the recovery levels expected for new gas plants, it set out clear expectations on when older grandfathered plants are required to meet the same requirements as new plants. The ID incorporated a phased approach to the more stringent requirements and encouraged operators of sulphur recovery plants to take early action to improve performance.

Grandfathered sulphur recovery plants that perform better than the minimum requirements specified in *ID 2001-3* have the option to file sulphur emission performance credit report forms and may use the credits to meet a portion of the sulphur recovery requirements at a future date (i.e., operate for a longer time or at a higher inlet rate before having to degrandfather the plant). All grandfathered sulphur recovery plants are now taking advantage of the emission credit program, and credits are continuing to grow every year, as would be expected in these early years when credits are easier to earn.

Acid gas flaring plants have no ability to earn credits and are subject to more stringent requirements over time.

In the last six years a number of plants have degrandfathered:[3] 12 plants have made upgrades to their plant, 8 plants have been relicensed to meet the requirements for new plants, and 5 plants have ceased operating. There are 35 grandfathered plants remaining. In addition, sulphur emissions have decreased substantially for both grandfathered acid gas flaring plants (emissions down 61 per cent) and grandfathered sulphur recovery plants (emissions down 30 per cent).

[1] Grandfathered plants are those that do not meet the sulphur recovery requirements for new plants listed in *ID 2001-3*. This includes some sulphur recovery plants and larger (sulphur inlet greater than 1 tonne per day [t/d]) acid gas flaring plants.

[2] Nongrandfathered plants are those with an approved sulphur inlet greater than 1 t/d meeting the requirements for new plants, as listed in *ID 2001-3*. This includes some sulphur recovery plants and all acid gas injection plants.

[3] Degrandfathered plants are those that did not previously meet the requirements of *ID 2001-3* for new plants but have now been relicensed to meet the requirements for new plants, as set out in the ID.

2 Summary of Performance for Grandfathered Plants, 2000-2005

2.1 Grandfathered Plants That Have Been Degrandfathered

In the last six years, 12 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 8 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 5 grandfathered plants have shut down. Further details on these plants are provided in Appendix 1.

Plants that were degrandfathered in 2005 included

1) Viking Bellshill
2) Suncor Simonette
3) CNRL Stromc (Holmberg)
4) Kereco Sturgeon Lake
5) Imperial Wilson Creek
6) Keyera Strachan
7) Bonavista Harmattan

As of June 2006, there are 19 grandfathered sulphur recovery plants and 16 grandfathered acid gas flaring plants remaining (see Appendix 2).

A detailed list of plants that have been degrandfathered in the last five years is in Appendix 3, along with the process used for improving sulphur recovery.

2.2 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2005

An analysis of the sulphur emissions and sulphur inlet for the specific plants that were listed in *ID 2001-3* as grandfathered follows in Sections 2.2.1 and 2.2.2. For the purpose of this analysis, plants that have degrandfathered since the ID was issued are included with the grandfathered plants.

2.2.1 Sulphur Emission Reduction

There have been substantial reductions in sulphur emissions from the grandfathered plants between 2000 and 2005, as shown in Figure 1.

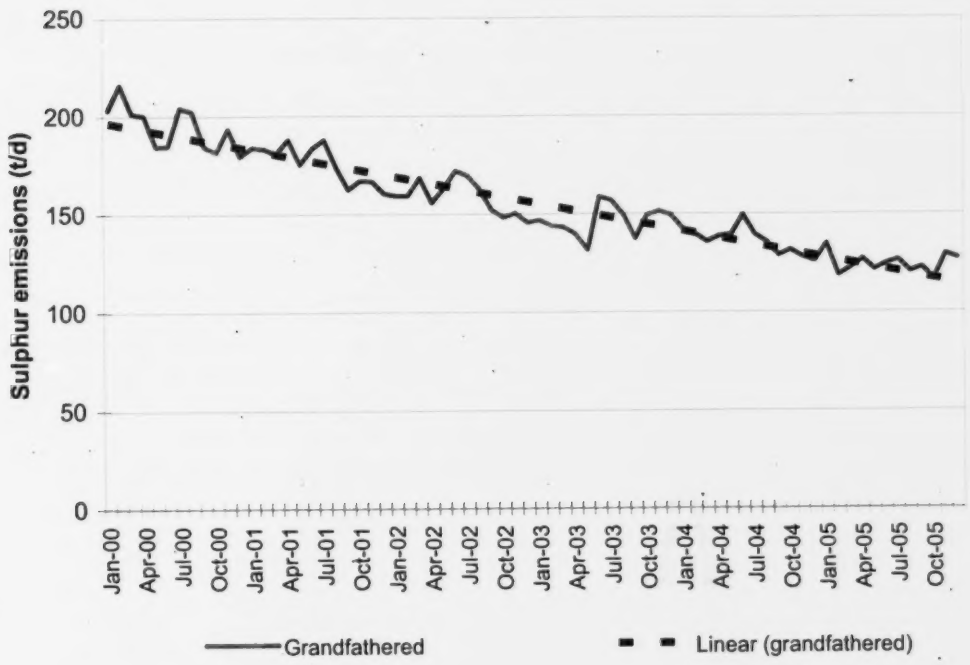

Figure 1. Sulphur emissions from grandfathered plants

The drop in emissions from grandfathered plants shown in Figure 1 is due to a decrease of about 61 per cent in emissions from the grandfathered acid gas flaring plants and a decrease of about 30 per cent from the grandfathered sulphur recovery plants between 2000 and 2005.

Of the 61 per cent decrease in emissions from grandfathered acid gas flaring plants from 2000 to 2005, 17 per cent is due to declining sulphur inlet. The other 44 per cent is due in large part to the acid gas injection facility installed at Apache Virginia Hills (Hope Creek) and ConocoPhillips Vulcan (Long Coulee), the installation of sulphur recovery at Petro-Canada Wilson Creek, and the installation of acid gas injection at the Viking Bellshill and Taylor Retlaw (Turin) Facilities. Between 2000 and 2005, 27 of the 28 grandfathered acid gas flaring plants showed emission reductions.

Of the 30 per cent decrease in emissions from grandfathered sulphur recovery facilities from 2000 to 2005, about 23 per cent is due to declining sulphur inlet. The other 7 per cent decrease in emissions is due in large part to improved operations at BP Windfall, CAMS Kaybob (1 and 2), Husky Strachan (Ram River), Central Midstream Kabob (3), and Shell Jumping Pound and the installation of acid gas injection at Keyera Brazeau. Between 2000 and 2005, 26 of the 28 grandfathered sulphur recovery plants reduced emissions, as shown in Appendix 4.

Appendix 4 lists sulphur production and emissions for each of the sulphur recovery plants for the years 2000 and 2005.

2.2.2 Decline in Sulphur Inlet

While improvements in operation and plant modifications have played a significant role in emission reductions at the grandfathered plants, as noted above, the reduction is also due to the declining sulphur inlets of these plants.

Figure 2 shows the decline in sulphur inlets for grandfathered gas plants.

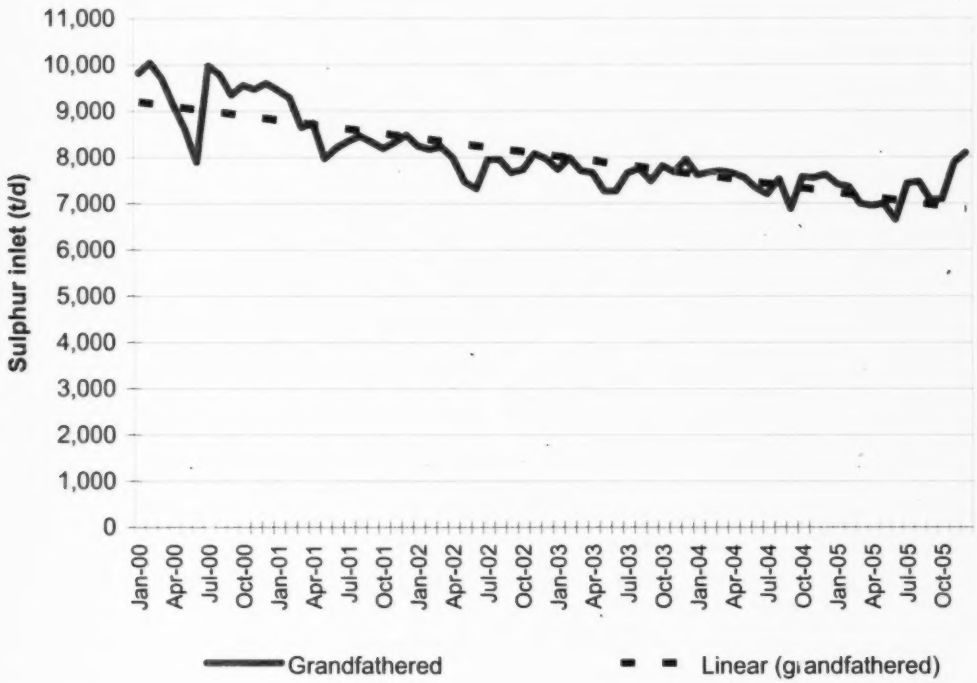

Figure 2. Sulphur inlet for grandfathered plants

2.3 Sulphur Emission Performance Credits (Emission Credits)

Emission credits can be earned by grandfathered sour gas plants with sulphur recovery that achieve recovery efficiencies higher than their required blended sulphur recovery efficiency. Credits cannot be transferred between facilities and do not apply to acid gas flaring plants.

Credit reports can help an operator

- operate at higher sulphur inlets,
- meet the required blended sulphur recovery efficiency, and
- defer upgrading for a longer period of time.

Each sulphur emission credit represents 1 tonne (t) of sulphur emissions that would have been emitted if the plant exactly met its minimum requirement. Credits must be earned before they can be used.

All plants that are able to file credit reports are doing so, and the emission credits are growing, as one would expect in this initial period. As of the end of the fourth quarter of 2005, over 59 000 t of sulphur emission credits had been earned (see Figure 3). The total sulphur emissions from grandfathered sulphur recovery plants in 2005 was only 39 000 t. Emission credits as of December 2005 equate to about 18 months of emissions from the grandfathered sulphur recovery plants.

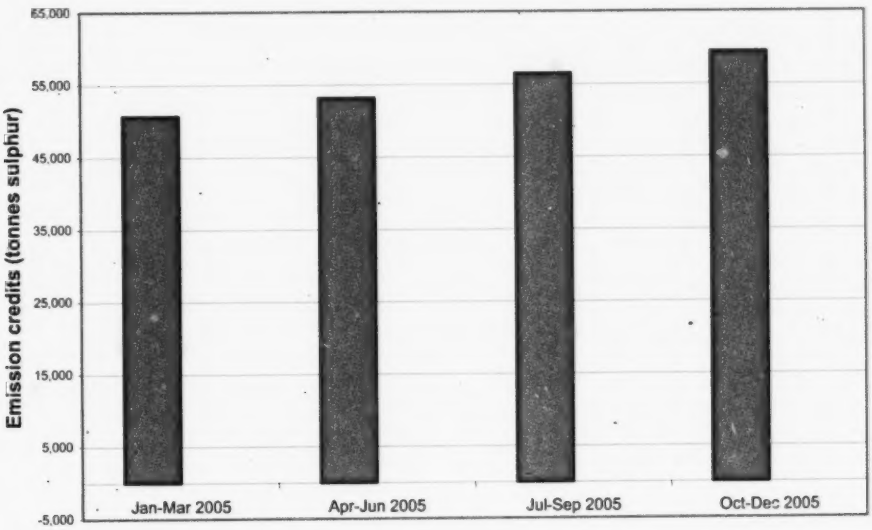

Figure 3. Net sulphur emission credits over time

Appendix 5 lists cumulative credits for each of the grandfathered sulphur recovery plants in 2005.

3 Summary of Performance for Nongrandfathered Plants, 2000-2005

The sulphur emissions and sulphur inlet for the specific sour gas plants (having a sulphur inlet greater than 1 t/d) that met the requirements for new plants when *ID 2001-3* was issued were also examined.

The drop in sulphur emissions from these nongrandfathered plants was about 17 per cent between 2000 and 2005. A smaller reduction in sulphur inlet, about 9 per cent, occurred over the same period. Details on these reductions on an individual plant basis for plants with sulphur recovery are given in Appendix 4.

4 Summary of Overall Performance for Grandfathered and Nongrandfathered Plants, 2000-2005

Examining sulphur inlet and sulphur emissions from both the grandfathered acid gas flaring and sulphur recovery facilities and nongrandfathered acid gas injection and sulphur recovery facilities reveals a 32 per cent drop in emissions. Of the 32 per cent, 16 per cent was due to improved performance and modifications, and the other 16 per cent was due to a decline in sulphur inlet.

Appendix 1 Grandfathered Plants That Have Been Degrandfathered, 2000-2005

In the last six years, 12 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 8 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 5 grandfathered plants have shut down.

The 12 facilities listed below had significant physical modifications to their plants to achieve higher sulphur recoveries.

Plants making modifications to meet the requirements for new plants

Plant name	Operator
1. Brazeau River	Keyera
2. Garrington (Olds)	Esprit
3. Homeglen (Rimbey)	Keyera
4. Bantry	AltaGas
5. Vulcan (Long Coulee)	Conoco Phillips
6. Wilson Creek	Petro-Canada
7. Rainbow	Husky
8. Edson	Talisman
9. Retlaw (Turin)	Taylor Management
10. Virginia Hills	Apache
11. Bellshill	Viking (2005 modifications)
12 Simonette	Suncor (2005 modifications)

Of the 8 plants listed below, 4 were relicensed to a higher sulphur recovery efficiency with existing equipment and/or minor modifications and 4 were relicensed to a lower throughput without modifications.

Plants relicensing to meet the requirements for new plants

Plant name	Operator
1. Okotoks (Mazeppa)	Mazeppa Processing
2. Crossfield East	PrimeWest
3. Sylvan Lake	NAL Resources
4. Sturgeon Lake	Kereco (2005)
5. Carson Creek	ExxonMobil
6. Strome (Holmberg)	CNRL (2005)
7. Wilson Creek	Imperial (2005)
8. Strachan	Keyera (2005)

Grandfathered plants that have ceased operating

Plant name	Operator
1. North Rosevear	Suncor
2. Bittern Lake	CNRL
3. North Caroline	BP Canada
4. South Caroline	BP Canada
5. Harmattan - Elkton	Bonavista (2005)

A detailed list of plants that have been degrandfathered in the last five years is in Appendix 2, along with the process used for improving the sulphur recovery.

As of June 2006, there are 19 grandfathered sulphur recovery plants and 16 grandfathered acid gas flaring plants remaining (see Appendix 2).

Appendix 2.1. Grandfathered Sulphur Recovery (SR) Gas Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Guideline Recovery for Approved Sulphur Inlet (%)	Daily Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change In Status (from *ID 2001-3*)
1	Brazeau R. - Keyera[1]	1108	98.4	98.4	466.0	67.3	Degrandfathered in 2003; became AGI
2	Brazeau R. (Nordegg) - Keyera	1121	93.5	95.9	49.8	38.2	
3	Burnt Timber - Shell	1131	96.5	98.4	560.0	412.4	
4	Caroline (North) 1-11 - BP Canada	1374	69.7	69.7	5.0	5.0	Plant shut down in 2003
5	Caroline (South) 4-20 - BP Canada	1104	85.0	89.7	9.8	6.8	Plant shut down in 2003
6	Carstairs - Bonavista	1020	90.0	98.2	72.2*	9.5	
7	Crossfield (Balzac) - Nexen	1050	98.0	98.5	1,730.1	414.6	
8	Edson - Talisman	1084	98.4	98.4	350.0	220.9	Degrandfathered in 2003; upgraded SR
9	Gold Creek - CNRL	1129	97.0	98.3	100.0	64.1	
10	Jumping Pound - Shell	1037	96.2	98.4	619.0	472.1	
11	Kaybob S. 1 & 2 - CAM Midstream Services	1107	98.4	98.5	1,107.7	540.6	
12	Kaybob S. 3 - Central Midstream	1144	98.1	99.5	3,629.7	1,009.6	
13	Lone Pine Ck. - ExxonMobil	1139	98.0	98.3	165.4	129.5	
14	Minnehik B. L. - Penn West	1047	95.6	95.9	49.2	22.0	
15	Okotoks (Mazeppa) - Mazeppa Processing	1530	98.4	98.4	586.6	263.4	Degrandfathered in 2002
16	Redwater - Imperial	1028	Fluctuating	95.9	12.2*	3.1	
17	Rosevear (North) - Suncor	1206					Plant shut down in 2001
18	Rosevear (South) - Suncor	1268	95.6	98.3	171.0	76.0	Plant consolidation 1206
19	Simonette - Suncor	1113	98.3	98.3	120.0	92.3	Degrandfathered in 2005
20	Strachan (Ram River) - Husky	1141	98.1	99.5	4,660.5*	2,301.8	
21	Strachan - Keyera	1133	98.4	98.4	971.1	264.9	Degrandfathered in 2005
22	Sturgeon Lk. - Kereco	1112	95.9	95.9	49.8	40.6	Degrandfathered in 2005
23	Teepee -Talisman	1296	92.0	95.9	25.0	17.5	
24	Waterton - Shell	1056	98.7	99.5	3,148.0	2,099.6	
25	Wildcat Hills - Petro-Canada	1054	97.5	98.3	287.5	181.3	
26	Wimborne - Devon	1081	95.5	98.3	235.0	182.1	
27	Windfall (West Whitecourt) - SEMCAMS	1034	98.3	98.5	1,356.1	777.6	
28	Zama - Apache[2]	1219	92.0	98.2	80.3	38.6	Baseline revision 2001

* Annual average sulphur inlet.

[1] KeySpan Brazeau River became an acid gas injection (AGI) facility in 2003. Injected sulphur volumes in 2005 were 134.4 t/d.

[2] As of October 2004, Zama has been delivering acid gas to its Apache Zama AGI plant. Delivered AGI was 5.45 t/d in 2005.

Appendix 2.2. Grandfathered Acid Gas Flaring Plants

		Plant Code	Guideline Recovery for Approved Sulphur Inlet (%)	2005 S Emissions (t/d)	Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-3*)
1	Ansell (Galloway) - CNRL	1417	69.7	0.37	1.40	1.3	
2	Bantry - AltaGas	1114	69.7	0.47	2.00	1.0	Degrandfathered in 2002; became SR
3	Bellshill Lake - Viking Holdings[1]	1280	89.7	0.11	5.77	3.8	Degrandfathered in 2005; became AGI
4	Big Bend - CNRL	1293	69.7	0.04	1.46	1.0	
5	Bigoray - Penn West	1138	69.7	0.69	2.96	1.8	
6	Bittern Lake - CNRL	1124	69.7		2.48	1.0	Plant shut down in 2000
7	Boundary Lake S - Penn West	1202	69.7	0.74	2.20	1.1	
8	Boundary Lake S - Talisman	1024	69.7	0.37	1.90	1.0	
9	Carson Creek - ExxonMobil	1062	69.7	0.35	0.83	1.0	Degrandfathered in 2004
10	Enchant - Taylor Management	1039	69.7	0.45	1.25	1.0	
11	Forestburg - Signalta	1365	69.7	2.15	4.50	4.0	
12	Greencourt - CNRL	1127	69.7	0.90	1.00	1.3	
13	Harmattan-Elkton - Bonavista	1083		0.09	0.53	1.0	dehydration and compressor unit.
14	Judy Creek - Pengrowth	1069	69.7	1.91	3.60	2.7	
15	Kaybob - Trilogy	1058	89.7	0.89	5.15	1.0	
16	Killam (Sedgewick) - AltaGas	1510	69.7	1.05	4.75	2.2	
17	Leduc - Woodbend - Imperial	1023	69.7	0.00	1.01	1.0	
18	Little Bow (Travers) - Bonavista	1150	69.7	0.80	1.60	1.2	
19	Retlaw (Turin) - Taylor Management[2]	1191	69.7	0.09	4.64	1.7	Degrandfathered in 2004; became AGI
20	Spirit River - Bonavista	1560	69.7	0.61	2.60	1.0	
21	Strome (Holmberg) - CNRL	1179	69.7	0.41	0.61	1.6	Degrandfathered in 2005
22	Sylvan Lake - NAL Resources	1070		0.25	0.75	1.0	Degrandfathered in 2002
23	Virginia Hills (Hope Creek) - Apache[3]	1135	95.9	0.09	16.00	5.2	Degrandfathered in 2004; became AGI
24	Vulcan - (Long Coulee) ConocoPhillips[4]	1100	69.7	0.00	4.90	2.7	Degrandfathered in 2002; became AGI
25	West Drumheller -Canetic	1109	69.7	0.18	2.99	1.1	
26	Whitecourt - Shiningbank	1115	89.7	2.28	7.50	3.5	
27	Wilson Creek - Imperial	1399		0.15	0.95	1.0	Degrandfathered in 2005
28	Wilson Creek - Petro-Canada	1096	69.7	0.18	4.70	2.3	Degrandfathered in 2001; became SR

[1] Viking Bellshill Lk started as an AGI facility in January 2005. Injected sulphur in 2005 was 4.19 t/d.

[2] Taylor Retlaw injected sulphur in 2005 was 1.92 t/d.

[3] Apache Virginia Hills injected sulphur in 2005 was 9.19 t/d.

[4] ConocoPhillips Vulcan injected sulphur in 2005 was 1.6 t/d.

Appendix 2.3. Nongrandfathered Sulphur Recovery Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Approved S Inlet (t/d)
1	Basing (Hanlan Robb) - Petro-Canada	1360	98.5	1,270.00
2	Bonnie Glen - Imperial	1045	89.7	10.00
3	Brazeau R. - Petro-Canada	1482	98.4	500.00
4	Brazeau R. (West Pembina) - Atco Midstream	1458	98.4	520.00
5	Campbell-Namao (Carbondale) - Atco Midstream	1638	69.7	1.15*
6	Caroline - Shell	1662	99.5	5,450.00
7	Crossfield E. - Primewest	1079	98.4	863.82
8	Garrington (Olds) - Esprit	1021	98.4	404.90
9	Harmattan - Taylor Processing	1060	98.6	82.70
10	Hays - Anadarko	1585	90.0	9.90
11	Homeglen Rimbey - Keyera	1004	98.3	150.00
12	Nevis - Duke Energy	1002	98.4	300.00
13	Progress - Anadarko	1506	96.5	49.50
14	Progress - Suncor	1629	69.7	2.50
15	Quirk Ck. - Imperial	1134	98.3	306.4*
16	Rainbow - Husky[1]	1105	98.3	213.49
17	Rainbow - AltaGas	1658	95.9	23.18
18	Saddle Hills (LaGlace) - EnCana	1892	98.4	483.10
19	Savanna Ck. (Coleman) - Northstar	1051	98.6	800.00
20	Sinclair (Hythe Brainard) - EnCana	1147	98.3	132.20
21	Swalwell - Pioneer[3]	1654	69.7	4.60
22	Valhalla - Primewest[2] (new)	1960	70.0	0.99

* Annual average sulphur inlet.

[1] Husky Rainbow started as an AGI facility in January 2002. Injected sulphur was 136.5 t/d for 2005.

[2] Previously was nongrandfathered acid gas flaring plant.

[3] Pioneer Swalwell started as an AGI facility in August 2005. Injected sulphur was 1.44 t/d.

Appendix 2.4. Nongrandfathered Acid Gas Injection Plants

	Nongrandfathered acid gas injection plants	Plant Code	Sulphur Recovery Equivalent Required (%)	Approved S Inlet (t/d)	2005 S Emissions (t/d)	2005 Sulphur Injected (t/d)
1	Acheson -Canetic	1628	69.7	4.65	0.00	0.66
2	Bistcho Lk - Paramount	1975	95.9	25.00	0.28	16.58
3	Bigoray - Keyera	1357	98.2	64.00	0.27	41.48
4	Boundary Lk S (Clear Hills) - CNRL	1880	95.9	19.21	0.00	9.54
5	Dizzy (Steen River) Caribou	1738	95.9	34.40	0.01	2.47
6	Dunvegan - Devon	1169	89.7	9.90	0.00	0.35
7	Eaglesham - (West Culp) Devon	1775	95.9	17.20	0.00	0.89
8	Galahad - Husky	1690	89.7	7.54	0.00	2.19
9	Golden Spike - Atco Midstream	1547	95.9	26.46	0.00	2.32
10	Gordondale - Duke	1668	98.2	54.31	0.03	22.79
11	Kelsey (Rosalind) - Thunder	1244	69.7	2.50	0.02	1.42
12	Leduc-Woodbend (Calmar) - MEC Operating Co.	1676	95.9	15.54	0.01	3.66
13	Marlowe (Dizzy) - Bearspaw	1765	95.9	19.70	0.01	0.76
14	Mitsue - Canetic[1]	1123	69.7	4.60	0.00	0.10
15	Mulligan (Fourth Creek) - Duke	1895	89.7	10.00	0.03	7.59
16	Normandville - Devon	1990	69.7	1.90	0.00	0.07
17	O'Chiese - Burlington	1970	95.9	14.53	0.01	0.51
18	Paddle River - Keyera	1089	69.7	1.50	0.00	0.66
19	Pembina - Keyera	1402	95.9	29.70*	0.05	15.87
20	Pembina - Imperial	1625	89.7	7.23	0.04	2.67
21	Pouce Coupe - Duke	1746	95.9	26.18	0.07	13.04
22	Provost (Hansman Lk) - Husky	1698	89.7	6.90	0.00	5.03
23	Provost (Thompson Lk) - Husky	1695	95.9	12.00	0.03	5.23
24	Puskwaskau - Devon	1964	89.7	5.15	0.00	0.17
25	Rainbow - ExxonMobil	1155	95.9	20.10*	0.29	9.51
26	Rycroft - Birchcliff	1793	95.9	21.00	0.01	4.31
27	Watelet (Glen Park) - Atco Midstream	1672	69.7	3.30	0.00	1.10
28	Wayne-Rosedale - EnCana	1888	89.7	5.90*	0.05	1.44
29	Wembley - ConocoPhillips	1520	98.3	124.00	0.12	57.76
30	Zama - Apache	1878&1978	98.3	247.00	0.24	44.84

[1] Previously a nongrandfathered acid gas flaring plant that had emissions of less than 1 t/d and is now an AGI facility.

	Grandfathered and nongrandfathered plants (sulphur recovery or acid gas flaring) that are now AGI facilities					
31	Bellshill Lake - Viking Holdings	1280	89.7	5.77	0.11	4.19
32	Brazeau R. - Keyera	1108	98.4	466.00	0.22	134.35
33	Rainbow - Husky	1105	98.3	213.49	0.68	136.51
34	Retlaw (Turin) - Taylor Management	1191	69.7	4.64	0.09	1.92
35	Virginia Hills (Hope Creek) - Apache	1135	95.9	16.00	0.09	9.19
36	Vulcan - (Long Coulee) ConocoPhillips	1100	69.7	4.90	0.00	1.60
37	Swalwell - Pioneer	1654	69.7	4.60	0.38	0.60

* Annual average inlet

Appendix 3. Plants That Have Been Degrandfathered

	Plants that have made modifications	Plant Code	Plant Name	Approved S Inlet max daily (t/d)	Modification Process
1	Plant Mods	1108	Brazeau R. - Keyera	400.00	(AGI)
2	Plant Mods	1021	Garrington (Olds) - Esprit	404.90	(SuperClaus)
3	Plant Mods	1004	Homeglen Rimbey - Keyera	150.00	(SuperClaus)
4	Plant Mods	1114	Bantry - AltaGas	2.00	(Xergy)
5	Plant Mods	1100	Vulcan (Long Coulee) - ConocoPhillips	4.90	(AGI)
6	Plant Mods	1096	Wilson Creek - Petro-Canada	4.70	(Claus)
7	Plant Mods	1105	Rainbow - Husky	213.50	(AGI)
8	Plant Mods	1084	Edson - Talisman	350.00	(SuperClaus)
9	Plant Mods	1191	Retlaw (Turin) - Taylor Management	4.64	(AGI)
10	Plant Mods	1135	Virginia Hills - Apache	16.00	(AGI)
11	Plant Mods	1280	Bellshill - Viking Holdings	5.77	(AGI)
12	Plant Mods	1113	Simonette - Suncor	120.00	(SuperClaus)
	Plants that have been relicensed to higher sulphur recovery efficiency or lower sulphur inlets				
13	Relicensed	1530	Okotoks (Mazeppa) - Mazeppa Processing	586.60	
14	Relicensed	1079	Crossfield E. - Primewest	863.82	
15	Relicensed	1070	Sylvan Lake - NAL Resources	0.75	
16	Relicensed	1112	Sturgeon Lake - Kereco	49.81	
17	Relicensed	1062	Carson Creek - ExxonMobil	0.83	
18	Relicensed	1179	Holmberg (Strome) - CNRL	0.61	
19	Relicensed	1399	Wilson Creek - Imperial	0.95	
20	Plant Mods	1133	Strachan - Keyera	971.10	

Appendix 4.1. Gas Plants with Sulphur Recovery, Year 2005 Minus Year 2000

	Plant Code	Field-Licensee	Change in production and emissions year 2005 minus year 2000 2005-2000 S Production (t/y)	2005-2000 S Emission (t S/y)
Grandfathered plants (in 2001)				
1	1034	Windfall (West Whitecourt) -SEM CAMS	(186,303.9)	(3,559.5)
2	1108	Brazeau R. - Keyera	(35,158.5)	(2,073.9)
3	1107	Kaybob S. 1 & 2 - CAM Midstream Services	(146,590.4)	(1,621.3)
4	1141	Strachan (Ram River) - Husky	(106,152.6)	(1,229.2)
5	1144	Kaybob S. 3 - Central Midstream	(11,379.6)	(1,071.5)
6	1037	Jumping Pound - Shell	4,546.4	(978.0)
7	1131	Burnt Timber - Shell	(32,998.5)	(778.1)
8	1084	Edson - Talisman	(15,231.7)	(568.0)
9	1081	Wimborne - Devon	(21,879.4)	(564.0)
10	1219	Zama - Apache	(14,405.1)	(563.7)
11	1206	Rosevear (North) - Suncor	(12,290.7)	(499.6)
12	1056	Waterton - Shell	(153,658.2)	(495.2)
13	1113	Simonette - Suncor	(23,687.5)	(491.8)
14	1104	Caroline (South) 4-20 - BP Canada	(2,186.0)	(349.5)
15	1133	Strachan - Keyera	(41,600.1)	(316.7)
16	1112	Sturgeon Lk. - Kereco	(7,024.4)	(313.2)
17	1054	Wildcat Hills - Petro-Canada	(8,739.2)	(259.7)
18	1121	Brazeau R. (Nordegg) - Keyera	(4,720.8)	(245.0)
19	1050	Crossfield (Balzac) - Nexen	(19,827.9)	(243.9)
20	1129	Gold Creek - CNRL	(8,030.5)	(240.2)
21	1047	Minnehik B. L. - Penn West	(4,009.2)	(163.2)
22	1296	Teepee - Talisman	374.7	(115.5)
23	1020	Carstairs - Bonavista	(1,187.5)	(110.8)
24	1374	Caroline (North) 1-11 - BP Canada	(903.1)	(86.8)
25	1530	Okotoks (Mazeppa) - Mazeppa Processing	(4,230.5)	(62.8)
26	1139	Lone Pine Ck. - ExxonMobil	(5,986.2)	(44.1)
27	1028	Redwater - Imperial	(403.1)	21.9
28	1268	Rosevear (South) - Suncor	(1,985.6)	27.9
	Totals		**(865,649.1)**	**(16,995.3)**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery				
1	1114	Bantry - AltaGas	231.9	(139.4)
2	1096	Wilson Creek - Petro-Canada	478.7	(972.4)
			710.6	**(1,111.8)**
New suphur recovery plant (new S recovery gas plants or plants previously licensed for less than 1 t S inlet /d)				
1	1960	Valhalla - Primewest	313.2	125.0
			313.2	**125.0**
Nongrandfathered plants (plants meeting the requirements for new plants)				
1	1079	Crossfield E. - Primewest	(73,926.5)	(1,644.3)
2	1105	Rainbow - Husky	(22,351.5)	(875.5)
3	1004	Homeglen Rimbey - Keyera	(5,203.4)	(871.3)
4	1021	Garrington (Olds) - Esprit	9,095.0	(660.0)
5	1662	Caroline - Shell	(221,644.9)	(333.2)
6	1458	Brazeau R. (West Pembina) - Atco Midstream	14,315.1	(218.9)
7	1002	Nevis - Duke Energy	(14,709.8)	(194.8)
8	1051	Savanna Ck. (Coleman) - Northstar	(22,140.1)	(120.7)
9	1060	Harmattan - Taylor Processing	(5,230.9)	(76.0)
10	1585	Hays - Anadarko	(376.5)	(40.5)
11	1654	Swalwell - Pioneer	(351.2)	(27.3)
12	1045	Bonnie Glen - Imperial	20.8	(24.0)
13	1638	Campbell-Namao (Carbondale) - Atco Midstream	(278.2)	(0.2)
14	1629	Progress - Suncor	182.6	-
15	1506	Progress - Anadarko	2,887.8	25.8
16	1658	Rainbow - AltaGas	4,261.2	51.5
17	1134	Quirk Ck. - Imperial	(6,821.3)	114.1
18	1147	Sinclair (Hythe Brainard) - EnCana	4,885.3	115.9
19	1892	Saddle Hills - EnCana	(11,561.6)	238.0
20	1360	Basing (Hanlan Robb) - Petro-Canada	(15,415.9)	510.7
21	1482	Brazeau R. - Petro-Canada	34,904.6	516.8
	Totals		**(329,459.2)**	**(3,513.9)**
	Grand totals		**(1,194,084.6)**	**(21,496.0)**

Appendix 4.2. Gas Plants with Sulphur Recovery, Year 2000

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Actual Sulphur Recovery Effic. (%)	Current Required Sulphur Recovery Effic. (%)	Total Annual Production (t/y)
Grandfathered Plants (in 2001)							
1	1034	Windfall (West Whitecourt) -SEM CAMS	286,311.3	4,616.6	98.4%	98.3	292,237.0
2	1108	Brazeau R. - Keyera	36,697.0	2,152.6	94.2%	92.1	35,158.5
3	1107	Kaybob S. 1 & 2 - CAM Midstream Services	234,341.8	2,756.9	98.9%	98.4	250,134.3
4	1141	Strachan (Ram River) - Husky	791,052.9	7,877.7	99.0%	98.1	781,009.3
5	1144	Kaybob S. 3 - Central Midstream	360,565.8	6,646.1	98.2%	98.1	369,708.4
6	1037	Jumping Pound - Shell	161,744.1	5,509.7	96.6%	96.2	158,522.1
7	1131	Burnt Timber - Shell	156,959.7	4,844.0	96.9%	96.5	152,115.5
8	1084	Edson - Talisman	73,009.3	1,421.2	98.1%	97.9	73,337.4
9	1081	Wimborne - Devon	57,618.0	1,833.9	96.7%	95.5	54,008.0
10	1219	Zama - Apache	15,117.5	583.9	96.1%	92.0	14,405.1
11	1206	Rosevear (North) - Suncor	10,771.6	499.6	96.1%	94.6	12,290.7
12	1056	Waterton - Shell	671,377.4	6,233.1	99.1%	98.7	679,224.2
13	1113	Simonette - Suncor	32,358.2	793.8	97.5%	96.5	31,239.2
14	1104	Caroline (South) 4-20 - BP Canada	2,483.7	349.5	86.2%	85.0	2,186.0
15	1133	Strachan - Keyera	97,769.5	1,169.6	98.8%	98.1	97,129.6
16	1112	Sturgeon Lk. - Kereco	18,698.9	729.2	96.2%	94.0	18,456.1
17	1054	Wildcat Hills - Petro-Canada	71,413.7	1,220.0	98.2%	97.5	66,931.2
18	1121	Brazeau R. (Nordegg) - Keyera	12,991.3	727.9	94.6%	93.5	12,842.1
19	1050	Crossfield (Balzac) - Nexen	144,323.2	2,408.8	98.3%	98.0	141,245.3
20	1129	Gold Creek - CNRL	20,071.4	514.9	97.6%	97.0	20,883.0
21	1047	Minnehik B. L. - Penn West	7,018.8	270.4	96.1%	95.6	6,748.4
22	1296	Teepee - Talisman	5,424.7	372.2	93.2%	92.0	5,070.9
23	1020	Carstairs - Bonavista	3,815.5	324.6	91.2%	90.0	3,370.0
24	1374	Caroline (North) 1-11 - BP Canada	1,039.2	86.8	91.2%	89.7	903.1
25	1530	Okotoks (Mazeppa) - Mazeppa Processing	95,120.2	1,260.7	98.7%	98.3	95,760.9
26	1139	Lone Pine Ck. - ExxonMobil	38,390.2	599.7	98.4%	98.0	37,232.3
27	1028	Redwater - Imperial	1,184.9	88.3	92.7%	Fluctuating	1,118.3
28	1268	Rosevear (South) - Suncor	16,104.4	457.5	97.6%	95.6	18,426.7
	Totals		**3,423,774.2**	**56,349.2**	**98.4%**		**3,431,693.7**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1114	Bantry - AltaGas	310.6	310.7	0.0%	-	-
2	1096	Wilson Creek - Petro-Canada	908.0	1,036.4	0.0%	-	-
			1,218.5	**1,347.1**	**0.0%**		**-**
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
1	1960	Valhalla - Primewest	-	-	**0.0%**	-	-
			-	-	**0.0%**		-
Nongrandfathered Plants (Plants Meeting the Requirements for New Plants)							
7	1079	Crossfield E. - Primewest	170,668.1	3,028.6	98.2%	98.0	169,921.2
17	1105	Rainbow - Husky	25,910.0	1,123.5	95.2%	95.0	22,351.5
11	1004	Homeglen Rimbey - Keyera	19,957.4	1,003.0	94.8%	92.0	18,208.7
8	1021	Garrington (Olds) - Esprit	103,220.0	2,152.2	97.9%	97.1	101,783.0
6	1662	Caroline - Shell	1,833,270.9	2,458.5	99.9%	99.8	1,844,827.3
4	1458	Brazeau R. (West Pembina) - Atco Midstream	107,983.1	1,624.1	98.6%	98.4	112,615.2
12	1002	Nevis - Duke Energy	37,590.7	467.5	98.8%	98.4	37,091.8
19	1051	Savanna Ck. (Coleman) - Northstar	137,197.0	1,369.9	99.0%	98.6	136,352.7
9	1060	Harmattan - Taylor Processing	11,515.1	164.6	98.6%	98.6	11,875.6
10	1585	Hays - Anadarko	2,390.2	129.0	94.5%	90.0	2,217.5
21	1654	Swalwell - Pioneer	517.6	138.9	79.3%	70.0	533.4
2	1045	Bonnie Glen - Imperial	3,281.6	125.8	96.1%	95.9	3,062.0
5	1638	Campbell-Namao (Carbondale) - Atco Midstream	364.59	0.2	100.0%	69.7	403.7
14	1629	Progress - Suncor	389.10	-	100.0%	69.7	336.7
13	1506	Progress - Anadarko	9,215.7	237.8	97.4%	96.5	9,060.8
16	1658	Rainbow - AltaGas	1,882.0	127.9	92.6%	70.0	1,597.4
15	1134	Quirk Ck. - Imperial	86,771.0	1,002.1	98.9%	98.3	90,372.6
20	1147	Sinclair (Hythe Brainard) - EnCana	28,431.8	296.2	99.0%	98.3	28,291.8
18	1892	Saddle Hills - EnCana	125,906.9	1,292.3	99.0%	98.4	126,382.7
1	1360	Basing (Hanlan Robb) - Petro-Canada	299,824.2	3,434.8	98.8%	98.5	288,911.9
3	1482	Brazeau R. - Petro-Canada	97,601.0	917.1	99.1%	98.4	96,505.4
	Totals		**3,103,888.0**	**21,094.0**	**99.3%**		**3,102,702.9**
		Grand totals	**6,528,880.7**	**78,790.3**	**98.8%**		**6,534,396.6**

Appendix 4.3. Gas Plants with Sulphur Recovery, Year 2005

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Annual Sulphur Recovery (%)	Current Required Sulphur Recovery Effic. (%)	Total Actual Production (t/y)
Grandfathered plants (in 2001)							
1	1034	Windfall (West Whitecourt) - SEM CAMS	107,519.5	1,057.10	99.0%	98.3	105,933.10
2	1108	Brazeau R. - Keyera	49,868.7	78.70	99.8%	98.4	Injected (49039.1)
3	1107	Kaybob S. 1 & 2 - CAM Midstream Services	105,192.4	1,135.60	98.9%	98.4	103,543.90
4	1141	Strachan (Ram River) - Husky	681,207.5	6,648.53	99.0%	98.1	674,856.70
5	1144	Kaybob S. 3 - Central Midstream	348,620.5	5,574.60	98.5%	98.1	358,328.80
6	1037	Jumping Pound - Shell	164,722.6	4,531.70	97.3%	96.2	163,068.50
7	1131	Burnt Timber - Shell	120,599.7	4,065.90	96.7%	96.5	119,117.00
8	1084	Edson - Talisman	58,950.5	853.20	98.6%	98.4	58,105.70
9	1081	Wimborne - Devon	33,704.3	1,269.91	96.2%	95.5	32,128.62
10	1219	Zama - Apache	8,802.1	20.23	0.0%	92.0	Delivered (9189.43)*
11	1206	Rosevear (North) - Suncor	-	-	0.0%	0.0	-
12	1056	Waterton - Shell	523,645.9	5,737.88	98.9%	98.7	525,566.00
13	1113	Simonette - Suncor	7,838.7	302.00	96.2%	**98.3**	7,551.75
14	1104	Caroline (South) 4-20 - BP Canada	-	-	0.0%	85.0	-
15	1133	Strachan - Keyera	57,407.3	852.90	98.5%	**98.4**	55,529.50
16	1112	Sturgeon Lk. - Kereco	11,969.8	416.03	96.5%	95.9	11,431.70
17	1054	Wildcat Hills - Petro-Canada	60,105.5	960.33	98.4%	97.5	58,192.00
18	1121	Brazeau R. (Nordegg) - Keyera	8,594.9	482.90	94.4%	93.5	8,121.30
19	1050	Crossfield (Balzac) - Nexen	124,884.0	2,164.90	98.3%	98.0	121,417.40
20	1129	Gold Creek - CNRL	13,349.9	274.70	97.9%	97.0	12,852.50
21	1047	Minnehik B. L. - Penn West	2,891.1	107.19	96.2%	95.6	2,739.20
22	1296	Teepee - Talisman	5,711.1	256.73	95.5%	92.0	5,445.60
23	1020	Carstairs - Bonavista	2,268.1	213.80	91.1%	90.0	2,182.50
24	1374	Caroline (North) 1-11 - BP Canada	-	-	0.0%	69.7	-
25	1530	Okotoks (Mazeppa) - Mazeppa Processing	92,600.9	1,197.90	98.7%	98.4	91,530.40
26	1139	Lone Pine Ck. - ExxonMobil	31,552.0	555.60	98.3%	98.0	31,246.10
27	1028	Redwater - Imperial	848.8	110.21	86.7%	Fluctuating	715.20
28	1268	Rosevear (South) - Suncor	17,202.5	485.39	97.1%	95.6	16,441.10
	Totals		**2,640,058.40**	**39,353.93**	**98.5%**		**2,566,044.57**
* Acid gas delivered into a Zama injection facility.							
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1114	Bantry - AltaGas	440.8	171.3	57.5%	69.7	231.9
2	1096	Wilson Creek - Petro-Canada	521.2	64.0	88.2%	85.0	478.7
			962.0	**235.3**	**75.1%**	69.7	710.6
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
1	1960	Valhalla - Primewest	449.8	125.0	71.5%	70.0	313.2
			449.8	**125.00**	**71.5%**		**313.20**
Nongrandfathered plants (plants meeting the requirements for new plants in 2001)							
7	1079	Crossfield E. - Primewest	95,865.5	1,384.30	98.6%	98.4	95,994.70
17	1105	Rainbow - Husky	38,010.8	248.05	99.5%	98.3	Injected (49824.88)
11	1004	Homeglen Rimbey - Keyera	12,121.80	131.70	99.0%	98.3	13,005.30
8	1021	Garrington (Olds) - Esprit	111,296.0	1,492.20	98.7%	98.4	110,878.00
6	1662	Caroline - Shell	1,639,255.9	2,125.30	99.9%	99.5	1,623,182.40
4	1458	Brazeau R. (West Pembina) - Atco Midstream	116,457.3	1,405.20	98.9%	98.4	126,930.30
12	1002	Nevis - Duke Energy	22,947.4	272.70	98.8%	98.4	22,382.00
19	1051	Savanna Ck. (Coleman) - Northstar	112,250.1	1,249.18	98.9%	98.6	114,212.60
9	1060	Harmattan - Taylor Processing	6,723.9	88.60	98.7%	98.6	6,644.71
10	1585	Hays - Anadarko	1,992.2	88.53	95.4%	90.0	1,841.02
21	1654	Swalwell - Pioneer*	543.5	111.57	64.1%	70.0	182.21
2	1045	Bonnie Glen - Imperial	3,211.6	101.84	96.8%	95.9	3,082.80
5	1638	Campbell-Namao (Carbondale) - Atco Midstream	124.08	-	100.0%	69.7	125.56
14	1629	Progress - Suncor	514.50	-	100.0%	69.7	519.30
13	1506	Progress - Anadarko	12,199.9	263.57	97.8%	96.5	11,948.59
16	1658	Rainbow - AltaGas	6,248.5	179.38	97.0%	95.9	5,858.60
15	1134	Quirk Ck. - Imperial	82,650.0	1,116.20	98.7%	98.3	83,551.30
20	1147	Sinclair (Hythe Brainard) - EnCana	33,868.4	412.05	98.8%	98.3	33,177.11
18	1892	Saddle Hills - EnCana	118,790.8	1,530.25	98.7%	98.4	114,821.12
1	1360	Basing (Hanlan Robb) - Petro-Canada	273,143.5	3,945.53	98.6%	98.5	273,496.04
3	1482	Brazeau R. - Petro-Canada	129,963.7	1,433.92	98.9%	98.4	131,410.01
	Totals		**2,818,179.5**	**17,580.07**	**99.4%**		**2,773,243.67**
		Grand totals	**5,459,649.7**	**57,294.3**	**98.94%**		**5,340,312.0**
*Pioneer Swalwell became an AGI facility in August 2005. Injected sulphur volumes in 2005 were 220.73 6 t/y.							

Appendix 5. Sulphur Credits Earned

		Grandfathered sulphur recovery gas plants	Credits				Cumulative Credits				Status
	Plant Code		Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	
1	1108	Brazeau R. - Keyera	-	-	-	-	-	-	-	-	Degrandfathered
2	1121	Brazeau R. (Nordegg) - Keyera	10.4	15.6	32.3	18.5	533.9	549.5	581.8	600.3	
3	1131	Burnt Timber - Shell	13.1	0.0	-12.8	-19.1	1,012.6	1,012.6	999.8	980.7	
4	1374	Caroline (North) 1-11 - BP Canada					-	-	-	-	Plant shut down
5	1104	Caroline (South) 4-20 - BP Canada					-	-	-	-	Plant shut down
6	1020	Carstairs - Bonavista	11.2	1.6	4.8	6.9	208.2	209.7	214.5	221.4	
7	1050	Crossfield (Balzac) - Nexen	33.1	93.0	92.1	60.2	1,502.6	1,595.6	1,687.7	1,747.9	
8	1084	Edson - Talisman					122.2	122.2	122.2	122.2	Degrandfathered
9	1129	Gold Creek - CNRL	37.1	21.9	37.7	21.6	84.1	106.0	143.7	165.3	
10	1037	Jumping Pound - Shell	246.0	95.6	157.7	473.3	2,682.9	2,778.5	2,936.2	3,409.5	
11	1107	Kaybob S. 1 & 2 - CAM Midstream Services	175.6	-65.9	189.1	216.3	2,377.3	2,311.4	2,500.5	2,716.8	
12	1144	Kaybob S. 3 - Central Midstream	262.2	267.7	187.9	304.2	2,064.7	2,332.4	2,520.3	2,824.5	
13	1139	Lone Pine Ck. - ExxonMobil	21.2	16.7	21.4	21.1	161.9	178.6	200.0	221.1	
14	1047	Minnehik B. L. - Penn West	5.6	5.6	3.7	3.4	62.8	68.4	72.1	75.6	
15	1530	Okotoks - Mazeppa Processing					-	-	-	-	Degrandfathered
16	1028	Redwater - Imperial	13.9	9.4	43.1	35.4	165.1	174.5	217.6	253.0	Variable inlet rate
17	1206	Rosevear (North) - Suncor[1]					-	-	-	-	Plant shut down
18	1268	Rosevear (South) - Suncor[1]	75.0	67.5	62.4	60.8	1,347.6	1,415.1	1,477.5	1,538.3	
19	1113	Simonette - Suncor	-50.9	19.5	2.8	0.0	641.4	660.9	663.7	663.7	Degrandfathered
20	1141	Strachan (Ram River) - Husky	1,645.7	1,231.4	1,482.9	1,024.7	21,990.5	23,221.8	24,704.7	25,729.4	
21	1133	Strachan - Keyera	-4.0	88.5	85.4	49.2	1,006.7	1,095.1	1,180.5	1,229.7	Degrandfathered
22	1112	Sturgeon Lk. - Kereco	0.0	0.0	0.0	0.0	590.6	590.6	590.6	590.6	Degrandfathered
23	1296	Teepee - Talisman	31.8	32.8	40.3	55.1	482.6	515.4	555.7	610.8	
24	1056	Waterton - Shell	132.8	268.7	496.8	264.7	6,233.7	6,502.4	6,999.2	7,263.9	
25	1054	Wildcat Hills - Petro-Canada	81.6	79.5	146.3	129.6	1,449.0	1,528.4	1,674.7	1,804.3	
26	1081	Wimborne - Devon	58.3	46.1	64.7	66.0	1,288.7	1,334.7	1,399.5	1,465.5	
27	1034	Windfall (West Whitecourt) - SEM CAMS	226.5	196.9	168.1	158.0	3,682.3	3,879.2	4,047.3	4,205.2	
28	1219	Zama - Apache[2]	-	-	-	-	980.6	980.6	980.6	980.6	Delivers acid gas to its Apache Zama AGI plant as of October 2004
		Totals	**3,026.06**	**2,491.81**	**3,306.72**	**2,949.83**	**50,671.9**	**53,163.7**	**56,470.4**	**59,420.3**	

[1] Plant consolidation.

[2] Apache Zama - shipping acid gas to adjacent AGI gas plant.